

The efficacy and welfare implications of surgically-placed crib rings in horses
(*Equus caballus*)

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Kaitlin Quirk
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Dr. Katherine Houpt VMD PhD Dipl ACVB

Abstract

Domesticated horses are often stabled and thus their natural grazing behavior is limited. Consequently, some animals develop stereotypic behaviors such as cribbing, an oral stereotypy linked to bowel obstruction, lower learning ability, dental wear, weight loss and general loss in value. The present study tested surgically-placed “crib rings” for their efficacy in cribbing control and effects on welfare. Six adult horses with a long-term history of cribbing were used. Small hog rings (copper covered steel, 1-5/32" or 1-1/2") were placed into each horse's gums, between the upper incisors, under sedation with 0.1 to 0.2 mg/kg Detomidine. They were recorded 24 hours per day in the stall with a mounted camera and a time-lapse recorder and recorded grazing with a handheld video camera in five-minute intervals several times per week. Blood was drawn daily to test for plasma cortisol concentration. Horses were observed for several weeks before and after surgery. Average time spent cribbing and eating, average bites per minute grazing and average cortisol levels were calculated and compared using the student's paired t-test with alpha-level 0.05. Horses spent significantly less time cribbing ($P=0.002$) and more time eating ($P=0.002$) post-operation. They also took significantly fewer bites per minute grazing with the rings placed ($P=0.004$). Cortisol levels were significantly higher ($p=0.001$) on surgery day but dropped by day one; there was no significant increase post-surgically. Thus, overall crib rings appeared effective in decreasing cribbing behavior. Four of the six horses, however, returned to cribbing due to loss or bending of the rings, thus long term efficacy is questionable. Increased post-surgical eating may have been a replacement for cribbing. Longer eating time and less grazing may also indicate discomfort; however, cortisol results did not indicate chronic stress.

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Introduction

The horse, *Equus caballus*, is a herbivorous herd animal and thus horses' natural behavior is to spend the majority of their time grazing in distinct social groups. In domestication, however, horses are typically kept in box stalls with little opportunity for turnout and social interaction. This may be the root cause of stress and frustration related stereotypic behaviors or 'stereotypies.' A stereotypic behavior is defined as one that is repetitive, relatively invariant and apparently functionless (Mason 1991). One such behavior is cribbing, characterized by grabbing a horizontal object with the upper incisors, contracting the neck and laryngeal muscles and producing an audible grunt.

In addition to being an indicator of frustration, cribbing has been linked to health problems such as severe colic with epiploic foramen entrapment (Archer et al 2004), decreased intestinal motility (McGreevy and Nicol 1998), gastric ulcers (Mills and MacLeod 2002; Nicol et al 2002) and tooth wear. It also generally decreases the value of the horse due to fence damage, unpleasant grunting noises and the development of thick neck muscles that may impair gait and headset in riding horses. Finally, cribbing has been linked to lower learning ability (Hausberger et al 2007) and is believed to have parallels to obsessive-compulsive disorder (Luescher et al 1991) and addiction (McBride and Hemmings 2005) in humans.

A great deal of interest has been placed in finding the causes and ways of preventing cribbing behavior due to the aforementioned health issues. Mechanical methods of controlling cribbing are the most common, using collars and straps that discourage flexing the neck by applying pressure or electric shock. Such methods, however, are often

inadequate for severe cribbers. Surgical methods and drugs have been developed, but they are often largely experimental, expensive and inconvenient. Thus, a less severe and less expensive surgical method may be ideal in these cases. The present study focused on “crib rings,” or hog rings surgically-placed in the upper incisors to prevent grasping of a horizontal object. The experimental objectives of this study were to determine: (1) the efficacy of the rings in controlling cribbing behavior and (2) the effects of the rings on horses’ welfare, using eating, grazing and plasma cortisol as indicators.

Review of the Literature

The causes of cribbing are varied and not fully understood. Much research is based on owner surveys and observational studies that have implicated multiple genetic and environmental factors. Cribbing incidence has been reported to be negatively correlated with management factors such as straw bedding, turnout with access to grass, ability to touch other horses and access to roughage (Bachmann et al 2003; Christie et al 2006). Cribbing is commonly believed to be a learned behavior; however, in a recent US owner survey conducted by Albright et al (2009), only 1.0% of horses began cribbing after being exposed to another cribber. In fact, a large genetic component was implicated, with Thoroughbreds having the greatest incidence, 13.3% compared with 4.4% overall. Experimental evidence also provides little support for this type of observational learning in horses (Lindberg et al 1999).

A genetic predisposition for feeding behavior has also been implicated; increased motivation for feeding behavior in foals has been linked to the development of abnormal oral behavior (Nicol and Badnell-Waters 2005). This higher motivation may lead to a

chronic state of feed-related frustration. Such frustration has been implicated in the development of cribbing through multiple mechanisms. Domestication may be an important factor due to the restriction in a box stall setting of horses' natural grazing behavior and due to common management practices related to feed.

Because horses are naturally foraging animals, the feeding of concentrate meals may affect gut function in ways that lead to or exacerbate such behaviors as cribbing. The clinical link between cribbing and gastric ulceration is believed to be caused by a high-grain diet that raises the acidity of the stomach; it has been shown that antacid diets reduce both gastric ulceration and cribbing in foals (Nicol et al 2002). It was predicted that horses crib to reduce gastric discomfort through the production of saliva, which contains natural buffers. Studies on saliva production, however, have shown varying levels of support for this hypothesis. Although cribbing does produce saliva, it is unclear whether the amount is sufficient to buffer the stomach (Moeller et al 2008).

It has also been suggested that stomach discomfort results in high stress levels that alter basal ganglia activity, causing both cribbing and the lower learning ability that is often associated with it (Hemmings et al 2007). Chronic stress may also result in alteration of the mesoaccumbens dopamine pathway, which is involved in the motivation phase of goal-oriented behavior; an enhanced motivational state has been suggested as a possible cause of stereotypy (McBride and Hemmings 2005). Studies observing basal plasma cortisol levels, however, have observed conflicting results: either no significant differences were found between cribbing and normal horses (Pell and McGreevy 1999) or

higher levels were found in cribbers, but without cortisol increase when cribbing was prevented (McGreevy and Nicol 1998). Studies have also shown conflicting results on plasma β -endorphin levels; Gillham et al (1994) found significantly lower levels in cribbing horses, higher levels were found by Lebelt et al (1998) and no difference was observed in studies by McGreevy and Nicol (1998) as well as Pell and McGreevy (1999). Thus, there is no strong physiological indication that cribbing serves to reduce stress.

Timing and type of feeding has also been found to affect cribbing; horses crib more frequently immediately following a sweetened grain meal (Gillham et al 1994). It is also known that such meals cause the release of endogenous opioids in the brain. Based on these findings, it was predicted that a connection exists between dopaminergic pathways in the brain and cribbing behavior. Cribbing is triggered by this opiate release and the motivation to crib slowly declines until the next feeding. Support for this hypothesis has been shown through the administration of opiate blockers and narcotic antagonists. Use of these drugs prevents cribbing completely during continuous infusion, with a return to cribbing when they are discontinued (Dodman et al 1987; Rendon et al 2001).

The success of these drugs is promising for the control of cribbing; at present, it is the only treatment that completely stops the behavior. However, these drugs are still largely experimental and require sustained release. Constant administration is inconvenient and expensive and thus widespread use is not presently feasible. The use of antacids for cribbing control has also shown some promise (Mills & MacLeod 2002); however, results are not yet strong enough to warrant large-scale use. Surgical methods have also

been studied, such as the modified Forssell's procedure, which involves cutting the muscles that flex the neck. Recently, however, the procedure has been called into question: a lower success rate than initially reported has been found and the surgery may also cause increased stress in the animal (Schofield & Mulville 1998). At present, the most common treatment relies on management practices and mechanical cribbing control through straps or collars that discourage neck flexion by applying pressure or electricity. Such methods are often inadequate to control severe cribbing and thus alternative methods may be useful. The present study focused on surgically-placed hog rings or "crib rings" to prevent grasping a horizontal object as a more humane surgical method of cribbing control.

Materials and Methods

Six adult horses, *Equus caballus*, were used in this study: five Thoroughbreds, two mares and three geldings, and a pony gelding; all were known cribbers. Small hog rings (copper covered steel, 1-5/32" or 1-1/2") were surgically inserted under sedation with Detomidine into each horse's gums, between the upper incisors (Fig. 1). The rings extend below the dental arcade so the horse cannot grasp a horizontal object and, therefore, cannot crib. This procedure was approved by the Institutional Animal Care and Use Committee (IACUC).



Figure 1. Position of Anti-Cribbing Rings in the Horse

All horses were housed in 3.3 x 3.3 m stalls of pipe rail (1.4 m high) at the Cornell University College of Veterinary Medicine research facilities. They had visual access, as well as auditory and olfactory contact, with at least one other horse, but no tactile contact. They were provided with wood shavings as bedding and given grass hay ad libitum. They were fed 1-2 kg of a corn, oat and soybean mixture containing 20% molasses (Respond[®]) at 07:00 and 13:00 hours and were turned out in a grassless paddock for 30-60 min/day. Before and after placement of the rings, horses were recorded in the stall 24 hours per day on 2-hour tapes using a mounted video recorder (Panasonic WV-BP310) and a time lapse recorder (Panasonic Time Lapse AG-6124). They were also recorded while grazing for five minute intervals several times per week, before and after surgery, with a handheld Sony Digital Handycam with 120x zoom. Grazing was conducted at approximately 15:00 hours each day, in front of the stabling facility. Blood was drawn daily from the jugular vein for determination of plasma cortisol level. This was conducted shortly before grazing. Cortisol concentration was determined using the Immunlite[®] competitive chemi-luminescence radioimmunoassay.

Grazing behavior was quantified by recording the amount of time the horse's head was down and recording the number of bites per second taken during that interval. "Head down" was defined as having the muzzle within one inch (2.5cm) of the ground for 1 second or longer and "bite" was defined as grabbing grass with the teeth and pulling. The time spent with the head down, number of bites, and average bites per minute were recorded for each five-minute grazing interval to obtain approximately four data points each before and after surgery. Behavior in the stall was quantified by recording the animal's behavior every minute from an ethogram of possible behaviors as shown in the table below (Table 1). The mean, median and standard deviation of the number of minutes per 24-hour tape was calculated for each behavior and each horse, obtaining three data points before and approximately thirteen data points after surgery.

Table 1. Ethogram of Possible Stall Behaviors and Their Abbreviations

<i>Stress/Stereotypic</i>	<i>Locomotive</i>	<i>Ingestion/Excretion</i>	<i>Other</i>
Cribbing (CR)	Walking (W)	Eat Grain (EG)	Standing (S)
Weaving (WE)	Trotting (T)	Eat Hay (EH)	Stand, Relaxed (SR)
Pawing (P)	Running (RL)	Using salt lick (SLT)	Grooming (GS)
Kicking (K)	Rearing (R)	Drinking (D)	Person Interaction (PI)
Mouthing (M)	Rolling (GSRO)	Foraging (GR)	Horse Interaction (HI)
Struggle (ST)		Urinating (U)	Rubbing Tail (RT)
Aggression (AG)		Defecating (DF)	

The average time spent cribbing and eating and average bites per minute grazing per day

was calculated pre- and post-operation and compared using the student's paired t-test with Minitab software at $\alpha=0.05$. Eating was taken as the time spent eating both hay and grain. Cortisol levels were also compared using the student's paired t-test at $\alpha=0.05$.

Results

I. Cribbing

The six horses spent significantly less time cribbing post-operation than before the crib-rings were placed ($p=0.002$). There was, however, much individual variation in cribbing; four of the six horses returned to cribbing within three weeks (Fig. 2). Bending and/or loss of rings coincided with cribbing relapse in these four horses.

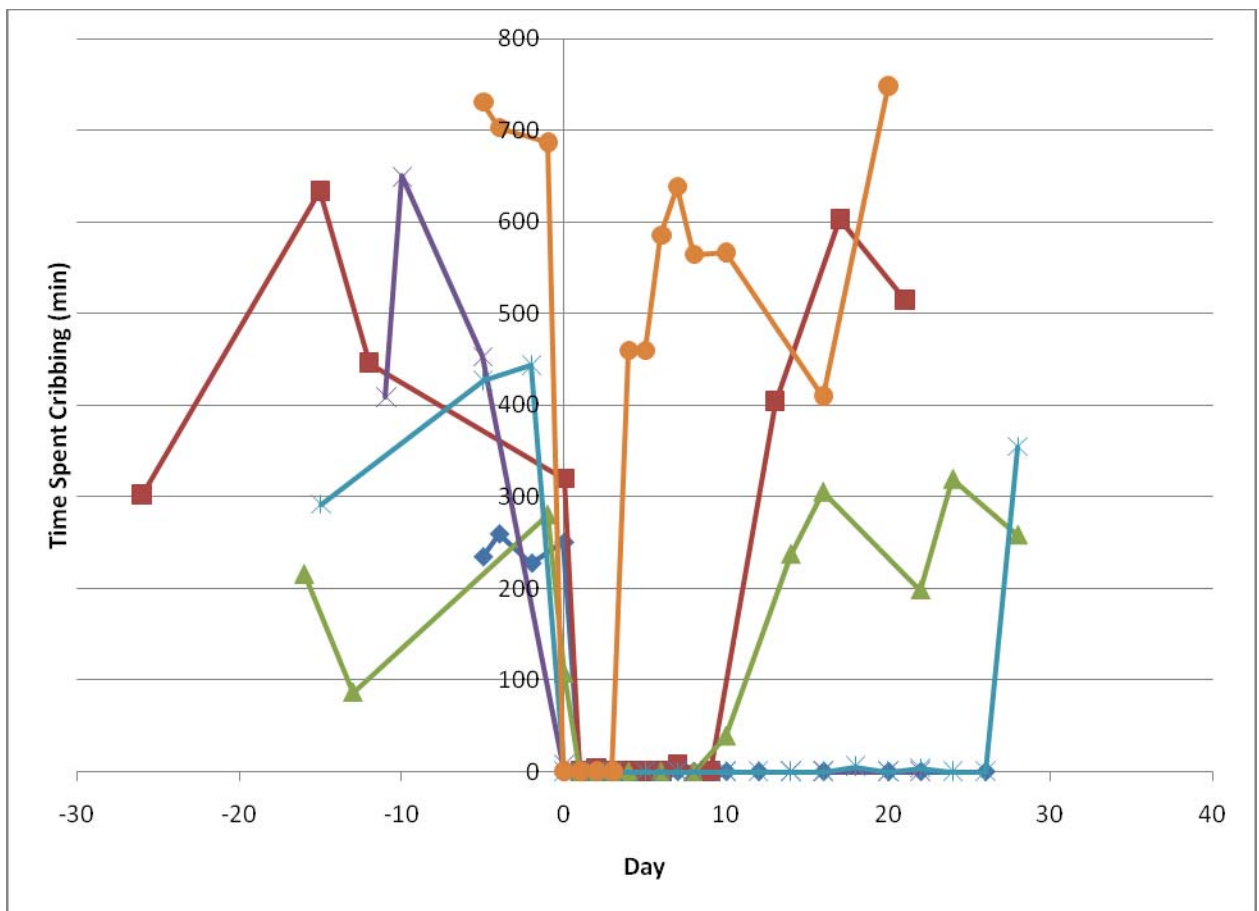


Figure 2. Time spent cribbing per day for all horses. Surgery day is indicated as day 0.

II. In-Stall Behavior

Horses spent significantly more time eating with the rings placed than without ($p=0.002$), an average of 633 minutes/day compared with 430 minutes/day pre-operation (Fig. 3).

Horses also spent almost twice as much time standing post-operation than pre-operation, an average of 620 minutes/day and 384 minutes/day, respectively. Results following loss of functional rings were excluded.

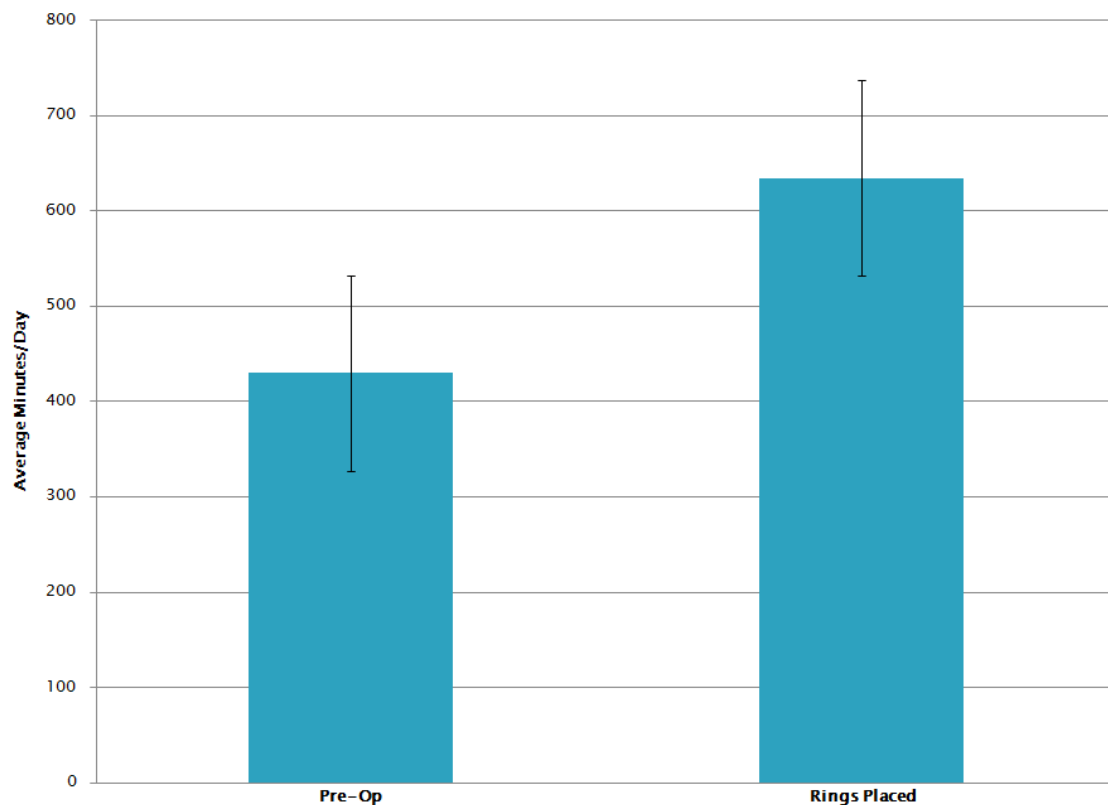


Figure 3. Average time spent eating with and without crib rings placed. Results are recorded in minutes per day.

The relative amount of time spent cribbing was much less post-operation, approximately 7% vs. 29%, while the amount of time spent standing and eating increased post-

operation, from a combined percentage of approximately 57% of stall time to 87% (Fig. 4). Relative amount of time spent standing compared with eating was roughly equivalent both pre and post operation.

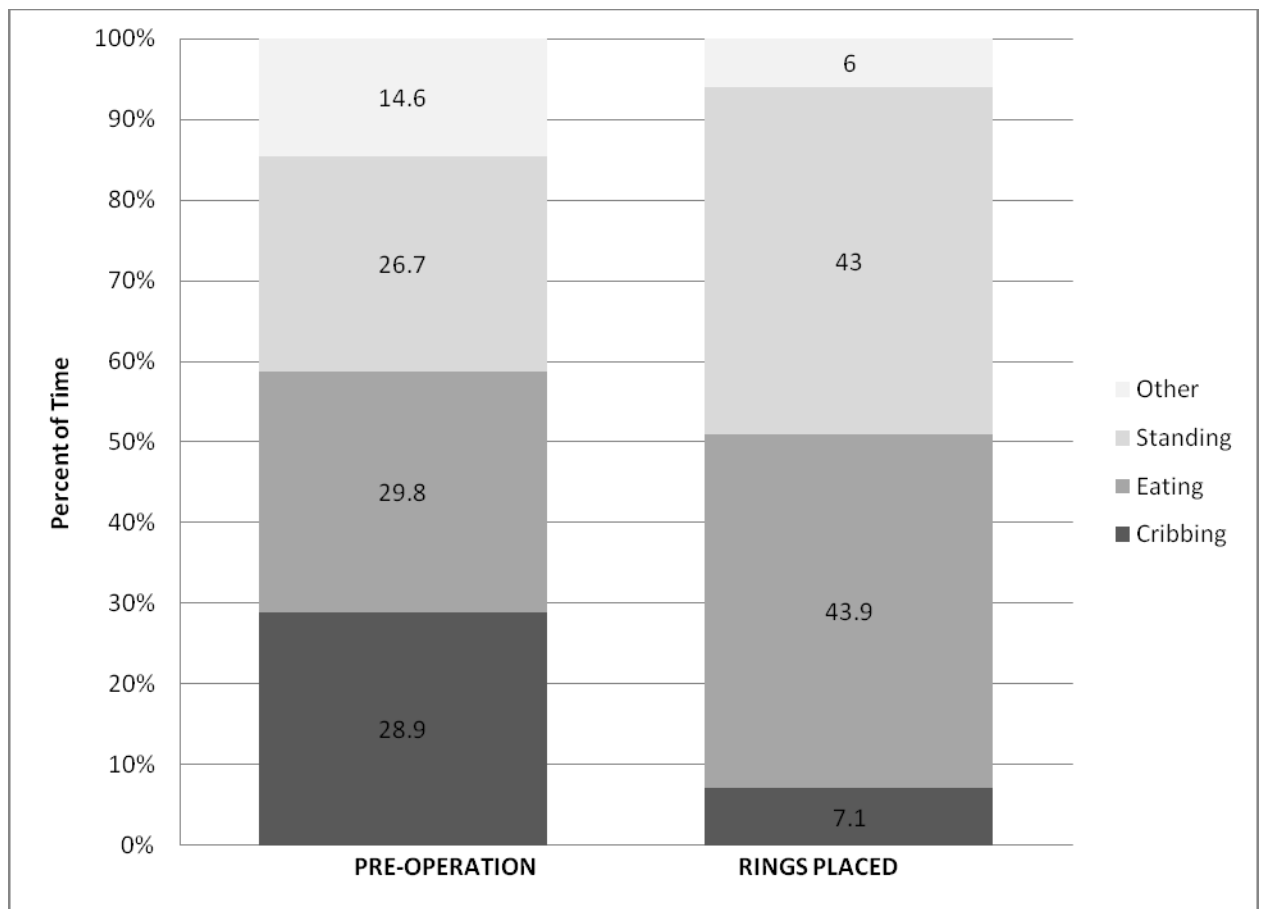


Figure 4. Relative amount of time spent performing major behaviors. Expressed in percentage of daily stall time.

III. Grazing

The six horses took significantly fewer bites per minute with the crib rings placed than before the operation ($p=0.004$). These results are displayed in the figure below.

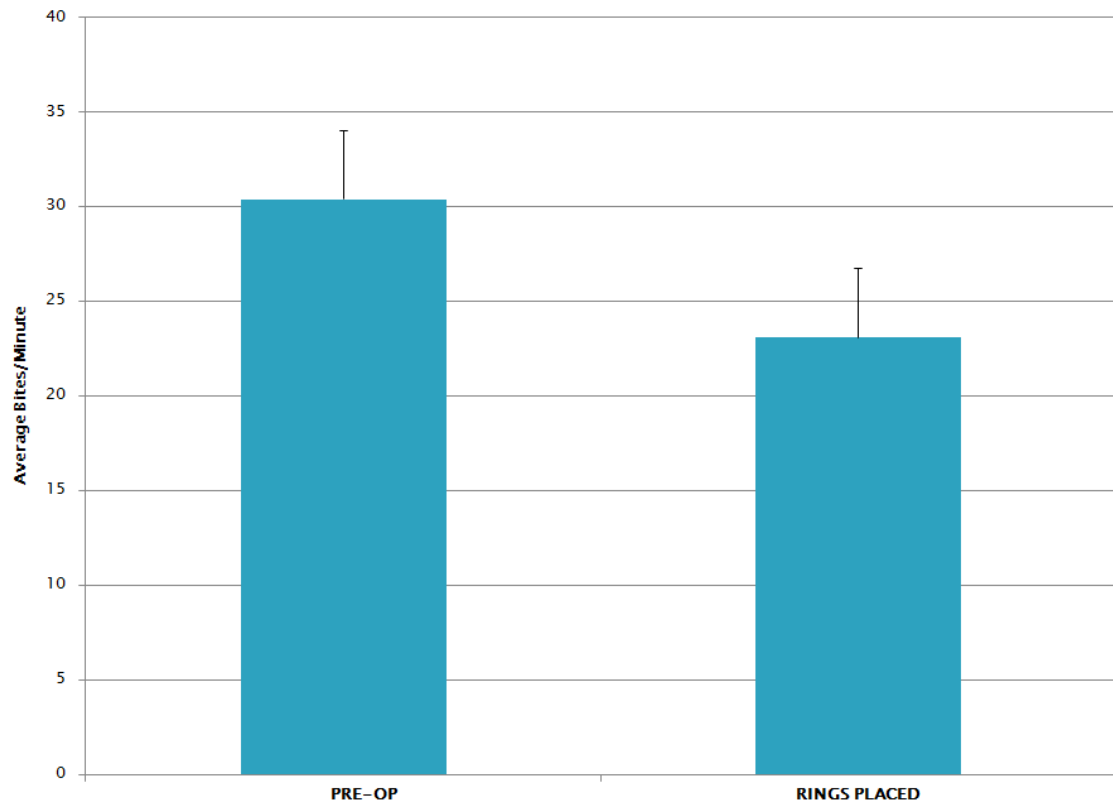


Figure 5. Average bites/minute taken while grazing outside pre-operation and with the rings placed. Results following loss of functional rings are excluded.

IV. Cortisol

Cortisol levels were significantly higher on surgery day 0, averaging 8.0 $\mu\text{g/dl}$ ($p=0.001$), but dropped back to normal levels by day 1 post-surgery (Fig. 6). Pre-surgical and post-surgical readings averaged approximately 3.8 $\mu\text{g/dl}$ and 3.2 $\mu\text{g/dl}$, respectively.

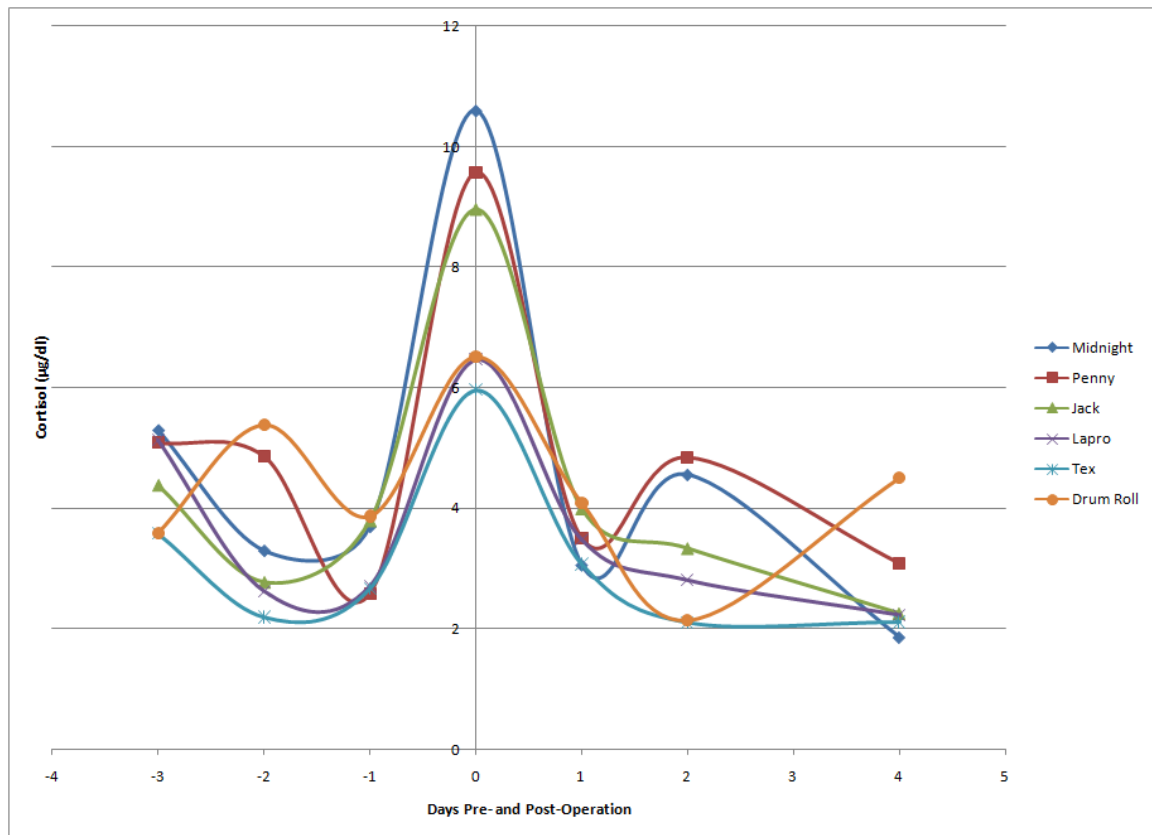


Fig. 6. Cortisol readings immediately before and after surgical placement of crib rings. Concentrations are expressed in $\mu\text{g/dl}$.

Discussion

The results indicate that crib rings are generally effective in controlling cribbing behavior while placed. The post-operative return to cribbing at levels equivalent to pre-operative crib time observed in four of the horses coincided with loss or bending of the rings; thus, long term efficacy becomes a question of ring durability or adequate ring placement. In order to assess the effect of the rings on grazing and eating, results in which rings were no longer functional were excluded from statistical analysis.

The finding that horses spend more time eating in the stall may be explained by some sort

of discomfort or pain associated with the rings that causes the horses to take longer to finish their hay and grain. It does not discourage eating altogether, possibly because the molars and premolars are unaffected; horses can still perform the grinding motion needed to chew their hay and grain. The placement of the rings on the upper incisors does, however, discourage biting. This may be responsible for the effects on grazing, as horses took fewer bites per minute.

The additional finding that horses spent a larger percentage of their time standing in addition to eating post-operation may provide an alternate explanation. The increased eating and standing time may simply have been a replacement for the time the horse would have spent cribbing as opposed to an indication of pain. Eating and standing time increased in roughly equivalent amounts post-operatively and replaced much of the time the horse would have spent cribbing. It is therefore likely that eating was at least partially a replacement for time spent cribbing. This explanation is supported by plasma cortisol levels; horses showed a spike in cortisol levels on surgery day, but returned to normal levels within a day. There was thus no evidence of chronic stress due to ring placement that would indicate any sort of pain or discomfort.

It would therefore be useful to determine if horses show similar behavioral patterns (less grazing and longer eating time) with other cribbing control methods. This may indicate that increased eating and decreased grazing is not a result of the crib rings themselves, but of the lack of cribbing behavior. In unpublished data by Houpt (2009) using the same in-stall observational methods with seven different horses, the Miracle Collar was tested

for efficacy and effects on behavior. The collar's effects on cribbing were comparable to the crib rings; horses spent roughly 2.1% of their stall time cribbing with the collar and 23.5% of stall time cribbing without. Horses also spent more time standing in the stall while they were cribbing less, approximately 42.2% compared to 31.3%. Eating, however, did not show as marked an increase, with relative eating time being 29.6% with the collar compared to 23.5% in the control. It is thus still unclear whether the rings played a role in increased eating time since the increase shown with the Miracle Collar has yet to be proven significant.

It is also difficult to determine the relative contribution of each explanation - discomfort vs. a replacement behavior for cribbing - to increased eating time due to the small sample size (n=6) and varying levels of data from each horse. Rings were damaged or lost at different times during the experiment and thus analysis of results "with rings placed" contains a variable number of days depending on how long each horse retained functional rings. It would therefore be useful in future study to use more horses and possibly more durable rings in order to obtain comparable levels of data on each horse. It would also be useful to further test various methods of cribbing control to clarify the role of crib rings in altering horses' eating behavior.

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